LINKING SAUDI ARABIA LORAN-C CHAIN TO MEDITERRANEAN CHAIN

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ABSTRACT

The National Institute for Standards (NIS) is maintaining the Egyptian National Standards. International Comparisons of NIS Frequency standard are continuously carried out. To obtain the required traceability, the most widely used system for time dissemination has been the navigational system of the U.S. Coast Guard-Loran-C. The only chain that was available for timing in Cairo, Egypt was the Mediterranean (7990). The NIS receives the Loran-C signals from Sellia Marina (7990-M) and Kargabarun (7990-Y). The data are stored and compared with the data received from BIH at Paris and USNO at Washington, D.C.

By 1985, however, two chains covering Saudi Arabia, came into operation. Since both Loran-C chains can be received at NIS, which is nicely situated between them, it was obvious that NIS can contribute to link them together. Kargabarun, Turkey (7990-Y) of the Mediterranean chain is at 1244 km from NIS and Ash Shaykh Homayd, (8990x) of the North Saudi Arabia at 408 km.

This paper presents the results obtained from the two Loran-C chains and comparisons with reports from BIH and USNO. If the necessary arrangements are made, continuous comparisons can be done and information sent to all interested organizations.

INTRODUCTION

The National Institute for Standards (NIS) time scale is compared with UTC by means of Loran-C signal reception. Loran-C chains, which use cesium beam frequency standards to control the frequency of the radiated signals, are maintained by the U.S. Coast Guard [1] so that the navigation pulses are synchronized to UTC (USNO).

The NIS has been performing daily time comparisons of its atomic frequency standard NIS CS(HP 5061A-004) with the Loran-C Mediterranean chain 7990 since 1983 . LC/7990 was the only receivable chain in Cairo, Egypt. By 1985, however, two chains, covering the Saudi Arabia came into operation. The two chains, cover the Red Sea, The Arabian Gulf, the Gulf of Aden and part of the Arabian Sea. It is a navigational system to provide coverage of the coastal waters of Saudi Arabia [2]. These stations are established for their own organizational requirement.

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Since both the Mediterranean chain and the North Saudi Arabia chain can be received at NIS, which is nicely situated between them, it is obvious that NIS can contribute to link them together.

The purpose of this paper, is to report the results observed thus far, of comparisons between Saudi Arabia Loran-C transmitters (8990, 7170) and the NIS frequency standard.
Comparison of the two Loran-C chains 7990 and 8990 are being made with reports from BIH and USNO. This paper deals with the results of these measurements.

NIS MONITORING SITE

Presently NIS monitors three loran-C chains. These chains are the Mediterranean (7990), the North Saudi Arabia (8990), and the South Saudi Arabia (7170). The daily time-interval differences are measured by two receivers for each chain. By using these data, relationships between the Mediterranean 7990 chain, which is under U.S. Coast Gaurd control, and the North Saudi Arabian 8990 chain can be determined [3]. Figure 1 shows the location of the NIS receiver and the Loran-C transmitters. As can be seen, the NIS is at a place of a preferable geographical condition to link the two Saudi Arabia chains with the Mediterranean chain.

THE SAUDI ARABIA CHAINS

The Saudi Arabia Loran-C stations data as well as the Mediterranean station received are given in table I. Distance computations are based on the receiving site calculation in Cairo, Egypt, at latitude 30° 03 N and longitude 31° 15 E.

TABLE I
Data of Transmitters received

CHAIN	RATE (us)	STATION	LATITUDE	LONGITUDE	DISTANCE (Km)	PWR (KW)
North Saudi Arabia	89,900	M Afif	23 48 36.8N	42 51 17.6E	1347.4	800
		X Ash Shaykh Homayd	28 09 15.9N	34 45 40.0E	407.9	400
South Saudi Arabia	71,700	M AL Khamasin	20 28 01.9N	44 34 52.3E	1715.7	800
Mediterranean	79,900	Y Kargabarun, Turkey	40 58 21 N	27 52 2.0E	1244	250

THE TIMING SYSTEM

The procedure followed at NIS has been to collect data on two Loran-C transmitters of the Saudi Arabia chains as received at Cairo, Egypt. Such signals were transmitted from ASH SHAYKH HOMAYD (8990X) of the North Saudi Arabia and ALKHAMASIN (7170M) of the South Saudi Arabia, and received at Cairo.

To insure continuity, two Loran-C receivers are used for each of the two chains. The data acquisition system is based at present on a personal computer which controls all the routine measurements inside the laboratory [4].

TYPICAL RECORDS

Comparisons are being made with the slave station at Kargabarun, Turkey (7990Y) of the Mediterranean chain, the slave station at Ash Shaykh Homayd (8990X) of the North Saudi Arabia chain and the master station at Al Khamasin (7170M) of the South Saudi Arabia chain.

Figure 2 represents a 7-day plot of the time interval differences of a ground wave signal from 8990X, 408 km over desert. Figure 3 shows a 7-day plot of data received from the transmitter 7170 M, where the signal arrives mostly over desert. As shown in this figure, the fluctuations of the time difference readings arose mostly at night. This is mainly due to sky wave contamination. Figure 4 illustrates typical day time, between 400 and 1700 UTC, ground wave observed at Cairo. All of the data available suggest an excellent ground wave stability when the sky wave part is eliminated. The phase change of a ground wave signal from 7990Y for a period of 7 days is shown in Figure 5. The path that the signal traverses is partially land, but primarily sea water.

COMPARISON WITH BIH and USNO

The transmitter used is the Y-slave station of the Mediterranean Sea chain, located on the island of Kargabarun (7990Y), off the coast of the northern part of Turkey. Using Lc/7990Y transmissions, differences of NIS-7990Y from August to November 1986 are shown in Figure 6a. Phase time readings are taken daily at 1000 UTC. The values for the relationship USNO-LC/7990 are published weekly in the Time Service Series 4 announcements [5] .

The investigations refer particularly to a time and frequency comparison between the NIS and the Bureau International de l'Heure (BIH) [6] . Figure 6b reports the values of the published data, in BIH monthly reports, from August to November 1986. By a simple calculation of NIS-LC/7990Y minus BIH-LC/7990Z one obtains UTC(NIS)-UTC(BIH). In Figure 6c the differences UTC(NIS)-UTC(BIH) via the Mediterranean chain 7990 as obtained from August to November 1986 are plotted. It is to be noted that BIH receives 7990Z where as NIS receives 7990Y.

The North Saudi Arabia transmitter used is 8990X located at Ash Shaykh

Homayd off the coast of the western part of Saudi Arabia on the Red Sea. The values of the relationship NIS-LC/8990X are recorded daily at 1000 UTC. Figure 7a reports NIS-8990X from August to November 1986. The differences (BIH-LC/8990) are illustrated in Figure 7b.

UTC(NIS)-UTC(USNO) is similarly calculated. Figure 8 reports the values of the published data, in series 4 UTC(USNO)-UTC(7990) from December 1986 to February 1987 as well as UTC(BIH)-UTC(7990) and the measurements obtained at NIS, UTC(NIS)-UTC(7990) for the same period. The differences UTC (NIS)-UTC(USNO) and UTC(NIS)-UTC(BIH) are plotted in Figures 9a and 9b respectively.

Figure 10a reports UTC(NIS)-UTC(8990) as obtained from December 1986 to February 1987. The differences UTC(BIH)-UTC(8990) and UTC(USNO)-UTC(8990) are illustrated in Figures 10b and 10c respectively.

These figures give an estimate of what could be gained by time comparisons using the Loran-C chain transmitted by Saudi Arabia if tracking data would be available.

Conclusions:

Relationships shown can serve to improve traceability to USNO for those users of Loran-C. With improved equipment, better results and continuity of comparisons can be assured for very long periods. Operating with a single cesium beam, as we do presently, is not convenient for continuous operation over long periods. It is worth noting that the clock used in this work has been in operation since 1981. Of course, several interruptions and failures had occured since then. Greater accuracy can be achieved if facilities for GPS reception are added.

AcKnowledgement:
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References:

1. W.J.Thrall, "Loran-C,an overview," In Proc. 13th Ann.PTTI Application and Planning Meeting, NASA Conf. Publ 2220, 1981.
2. W.A.DeGeorge, W.J.Garmany and R.V.McKeown, "Loran-C in Saudi Arabia," Private Communication.
3. Laura G.Charron, "Relationships between U.S.Naval Observatory, Loran-C and the Defense Satellite Communication System,".
4. G.Kamas and J.L.Jespersen "A new frequency Calibration service offered by the NBS," Proc. 37th Annual Freq.Control Symp.,pp 506-512,(1983).
5. US Naval Observatory Daily Phase values Series No.4.
6. Observatoire de Paris, monthly reports.

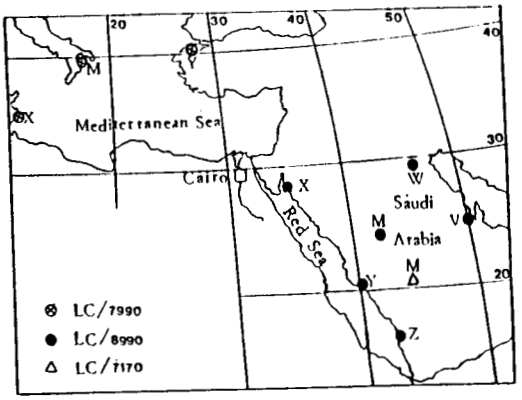
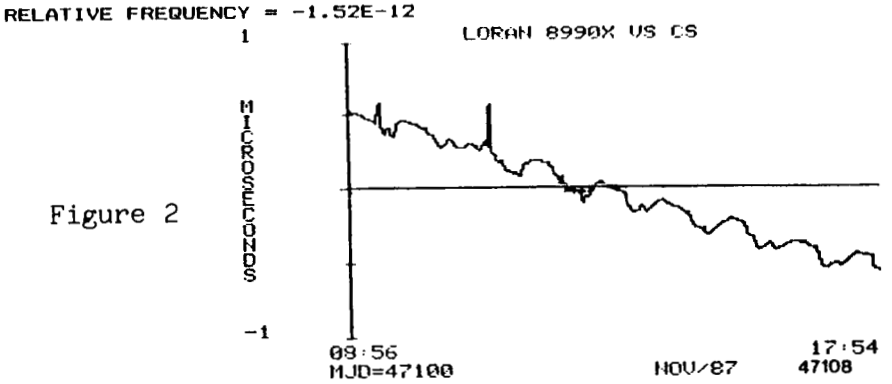


Figure 1 Location of Loran-C transmitters and NIS receiver

Figure 2



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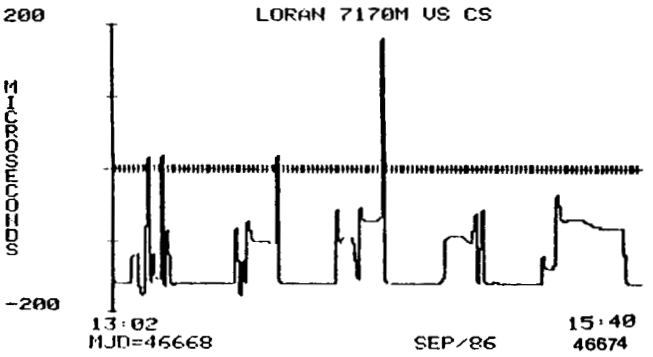

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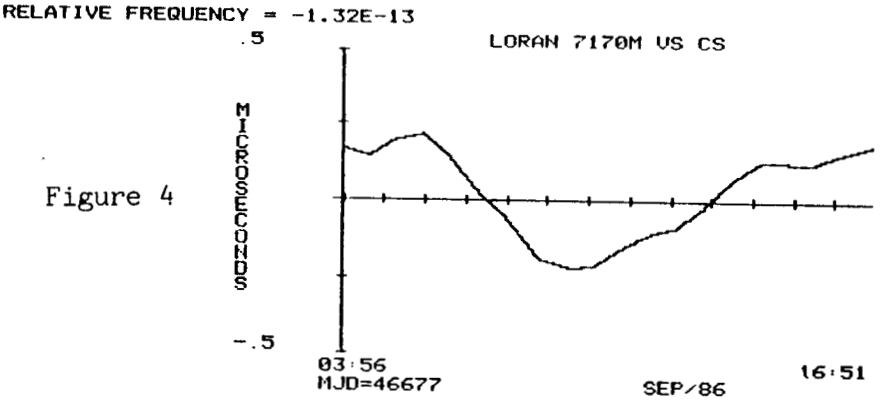

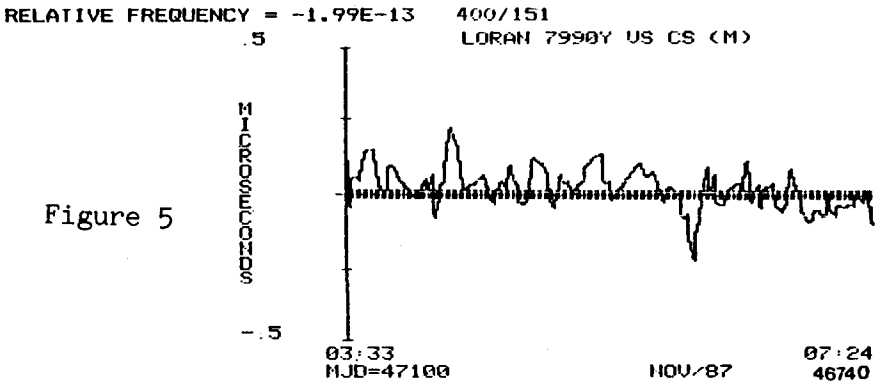

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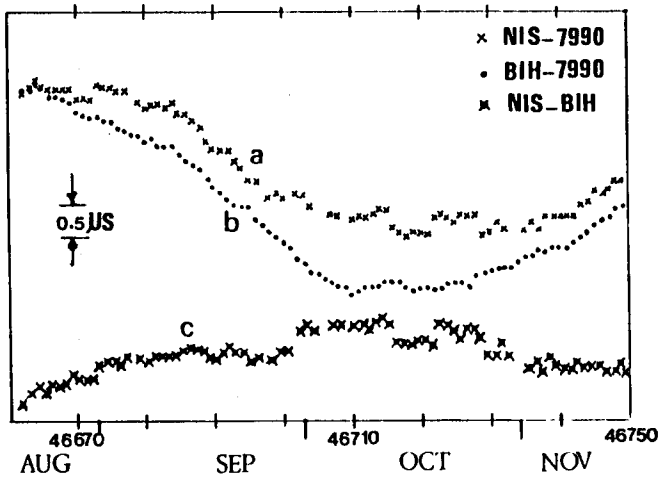

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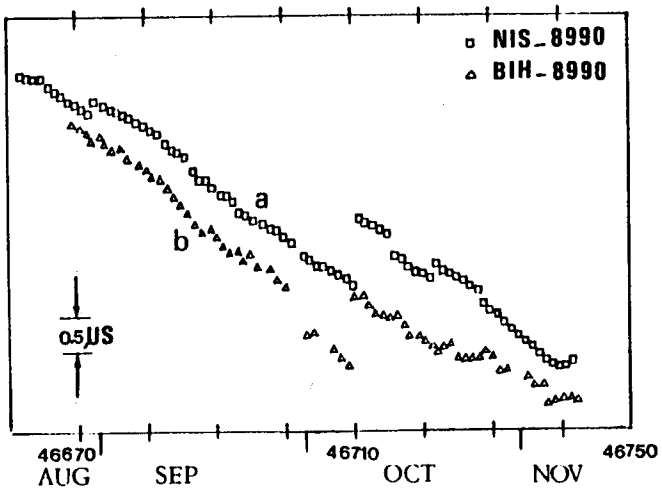
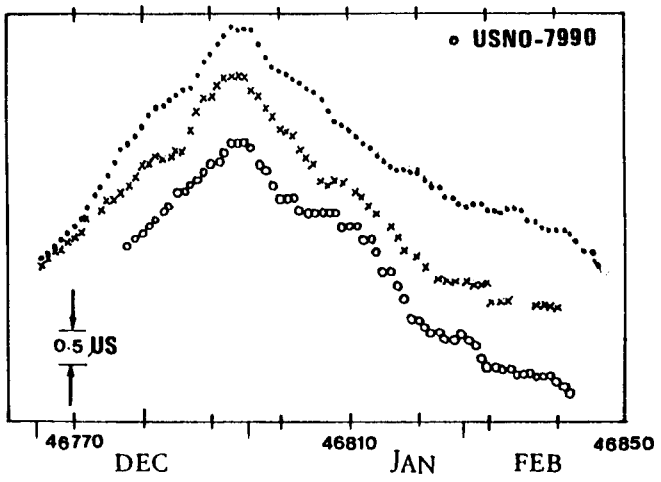


Figure 7

Figure 8



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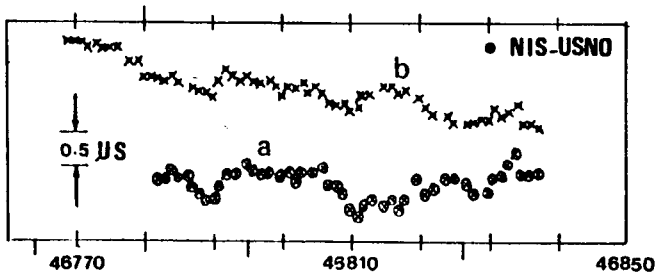
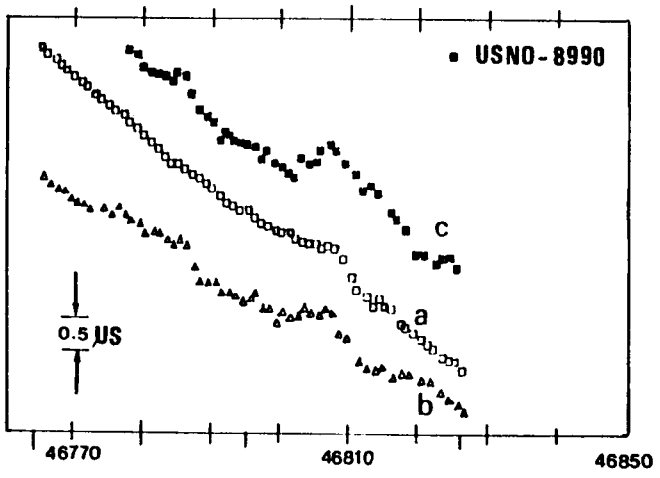


Figure 10



Brad Parkinson, Stanford University: Do you have firm plans to incorporate GPS into this comparison process?

Dr. Samuel: Yes.

Mr. Parkinson: When do you expect that to happen?

Dr. Samuel: When I get the funds.

Prof. Leschiutta, Politecnico–Elettronica: This is not a question, but rather a comment. Everyone is aware of the interest of the international timing community in having the Saudi–Arabian chain synchronized. The CCIR took the opportunity recently to ask Saudi–Arabia to make an effort to synchronize the chain to UTC(BIH). I think that will be done soon.